IFIP

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INWG - PROTOCOL NOTE #8

U K POST OFFICE

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FLOW CONTROL

Attached is a recent CCITT SGVII contribution on Flow Control by the UK Post Office.

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SOURCE : UNITED KINGDOM POST OFFICE

TITLE : SOME CONSIDERATIONS ON FLOW CONTROL FOR INTERNATIONAL PACKET TRANSPORT

(820)

1 INTRODUCTION

This paper outlines the flow control principles proposed for the United Kingdom experimental packet switched service, and shows how they may be applied to a packet transport service for use over international links. It should be read in conjunction with the contribution "International Packet Mode Operation for Data Transmission".

2 LEVELS OF PROTOCOL

The EPSS protocols between exchanges consist of a number of levels, each depending upon the correct operation of levels below, but being essentially separate from them.

The levels of protocol (in ascending order) are:-

2.1 BIT SYNCHRONISM

This level ensures that a bit transmitted at one end of the link is correctly interpreted at the receiving end. This is a function of the network.

2.2 BYTE SYNCHRONISM

Groups of 8 data bits are regarded as an entity (in line with the X series Recommendations) for the purposes of packet header information, data field length and error control information. The proposed system is based on a contiguous transfer of bytes during and between users' data packets and hence packets may only start at the beginning of a byte (and not at any position in the transmitted data bit stream). This is a function of the network.

2.3 LINE SIGNAL LEVEL

Three types of byte pattern may be present on a transmission link (other than packets).

2.3.1 Idle 1

This indicates that the link is operating and informs the receiver that the sending exchange is ready to receive a packet. In Fig 1, B is ready to receive a packet from A.

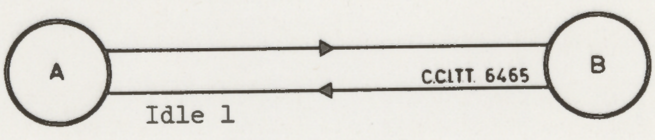

Figure 1

2.3.2 Idle 2

This indicates that the link is not operating correctly. In Fig 2, B is not receiving meaningful information from A and so transmits Idle 2 to A. This could occur if loss of bit or byte synchronism is suspected on the link A to B.

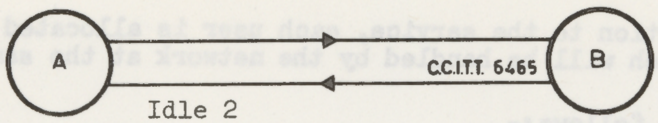

Figure 2

2.3.3 Idle 3

In Fig 3, this indicates that, although the link is operating correctly, exchange B is unable to handle any further packets received and that exchange A should not transmit packets while Idle 3 is being received.

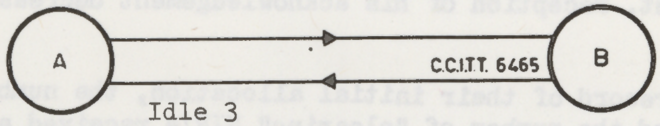

Figure 3

Exchanges must be able to recognise the above line signals and, in addition, be able to recognise that a packet is being received.

2.4 PACKET LEVEL BETWEEN EXCHANGES

This level is responsible for maintaining control of packet transfer. Thus packets received are checked for errors and are acknowledged as correct or discarded accordingly.

Up to 16 different packets may be transmitted on a link before an acknowledgement is received (or an error is assumed). Where no acknowledgement is received by the transmitting exchange before a pre-determined time has expired, the packet is re-transmitted. Further failure to receive an acknowledgement results in up to two attempts to transmit the packet by an alternative route. If it is still not possible to successfully receive an acknowledgement to the packet confirming its delivery to the next exchange, the packet is discarded by the transmitting exchange and the sending user informed by means of a Network Information Packet (NIP) formed by the last exchange at which the packet was successfully received.

The acknowledgement is in the form of a special type of packet which contains the link sequence numbers of the packets being acknowledged in its data field.

2.5 CUSTOMER TO CUSTOMER CONTROL LEVEL

The above levels 2.3.3 and 2.4 ensure that the overall number of packets received by exchanges at any time is not too great, and also limit the amount of storage which needs to be provided to store packets awaiting acknowledgement.

However in the mode of operation of the EPSS which is analogous to packet transport, further controls exist which limit the rate at which individual users may transmit packets.

At the time of connection to the service, each user is allocated a maximum number of packets which will be handled by the network at the same time.

This is controlled as follows:-

A user X transmits a packet to his local exchange A from where it is acknowledged if it is received without error. The local exchange increases by one, a register of the number of packets transmitted by user X. The packet is then routed thought the network, being acknowledged on a link-by-link basis until it is delivered to the addressee Y who acknowledges its correct receipt to his own local exchange B.

A Network Information Packet (NIP) is generated by exchange B and routed back to exchange A.

The NIP is then delivered to user X informing him that he may transmit one more packet, reception of his acknowledgement decreasing by one the register r.

Users keep a record of their initial allocation, the number of packets transmitted and the number of "clearing" NIP's received and may thus calculate the number of packets which they may transmit at any time.

In effect a user may be considered to make a number of single packet 'calls' and receipt of confirmation that the 'call' record has been cleared permits the user to initiate another 'call'.

Figure 4 shows the procedure described above.

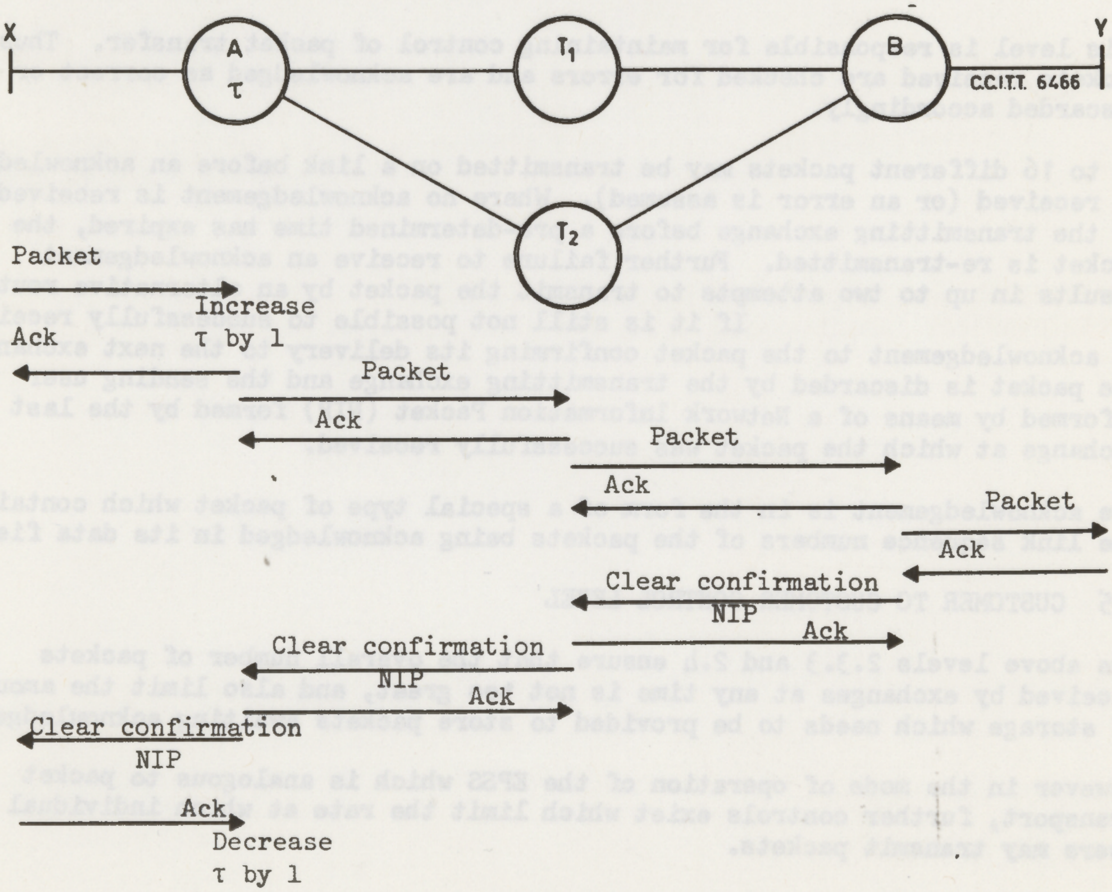

Figure 4

2.6 APPLICATION LEVEL

The data field of a customer packet must be an integral number (from 0-255) of 8-bit bytes, but there is no restriction on the sequence of bits which may be used in the data field.

The EPSS does not impose any constraints on application level protocols, but the UKPO is participating in discussions between potential users of the system to define some general standards.

3 PROPOSAL

The UKPO considers that adequate control of the rate at which packets are accepted by a network offering packet transport is essential to avoid network congestion.

It is believed that the procedures described in Section 2 will provide the necessary control and that they could be applied internationally, as follows:-

3.1 In Fig 5, each national network is assumed to have a control mechanism which prevents an overall build up of packets within the network, that is, the instantaneous maximum total input rate is limited to the instantaneous maximum total output rate.

In addition, a mechanism is assumed which imposes a limit on the number of packets which may be intransit through the network from each individual user.

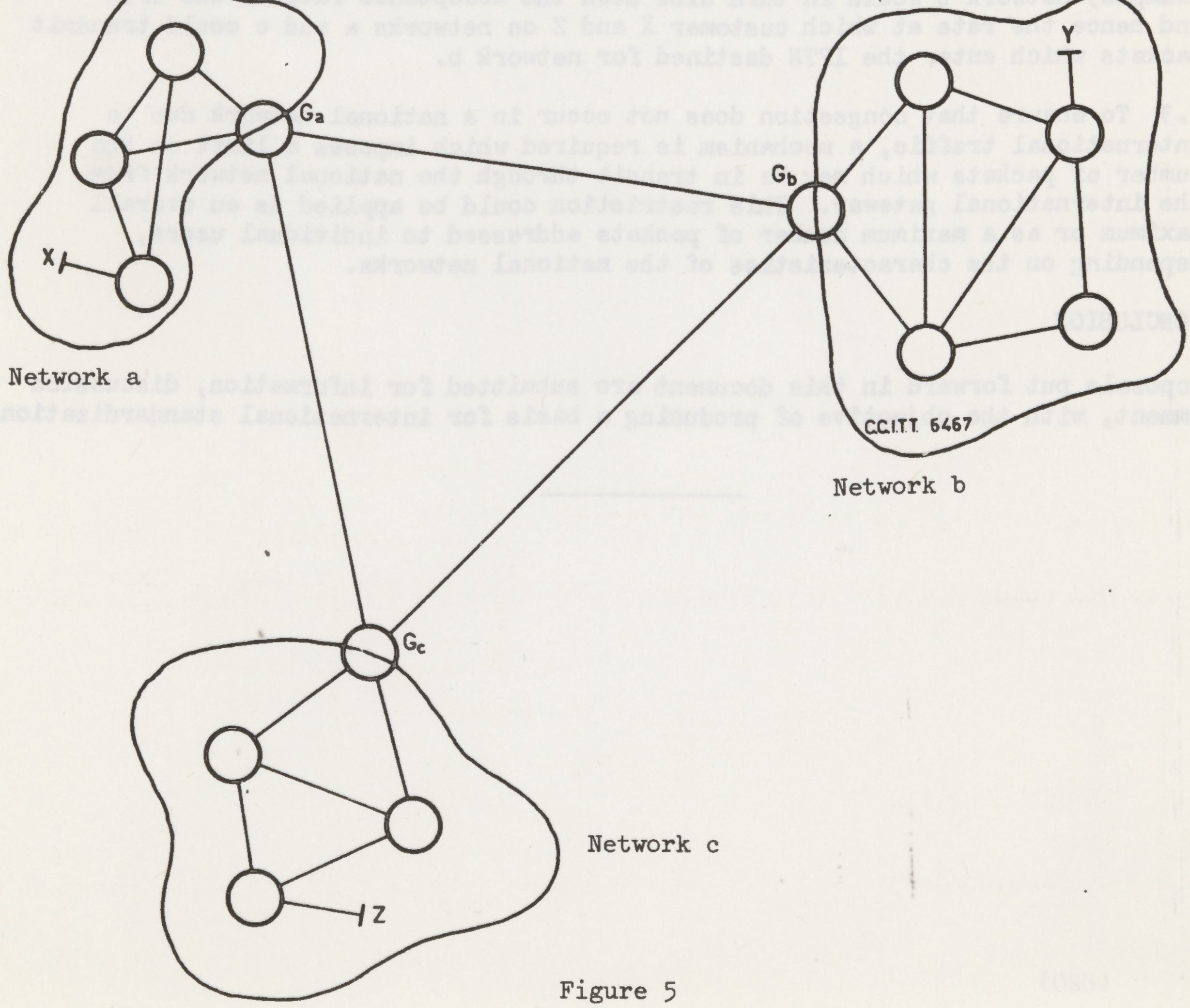

Figure 5

3.2 If user X wishes to send a packet to user Y, he will be permitted to launch the packet so long as he satisfies the flow controls for his own network, Na. The packet will be delivered to his gateway Ga if the international transit network is capable of accepting more traffic.

Packets will be delivered into Nb by Gb in accordance with the flow control rules for Nb and thence to user Y.

Packet handling may therefore be considered to take place in three separate stages, that is:-

3.2.1 By network a.

3.2.2 By the international packet transit network (IPTN).

3.2.3 By network b.

The flow control rules of each network would apply independently within its own network. Overall flow control would be maintained since each network would restrict entry of further packets (a) altogether or (b) those destined for particular customers, depending on the instantaneous state of the network and the flow control mechanisms available.

Using the procedures in Section 2, restriction of incoming packets by (for example) network b would in turn slow down the acceptance rate of the IPTN and hence the rate at which customer X and Z on networks a and c could transmit packets which enter the IPTN destined for network b.

3.3 To ensure that congestion does not occur in a national network due to international traffic, a mechanism is required which imposes a limit on the number of packets which may be in transit through the national network from the international gateway. This restriction could be applied as an overall maximum or as a maximum number of packets addressed to individual users, depending on the characteristics of the national networks.

4 CONCLUSION

The proposals put forward in this document are submitted for information, discussion and comment, with the objective of producing a basis for international standardization.